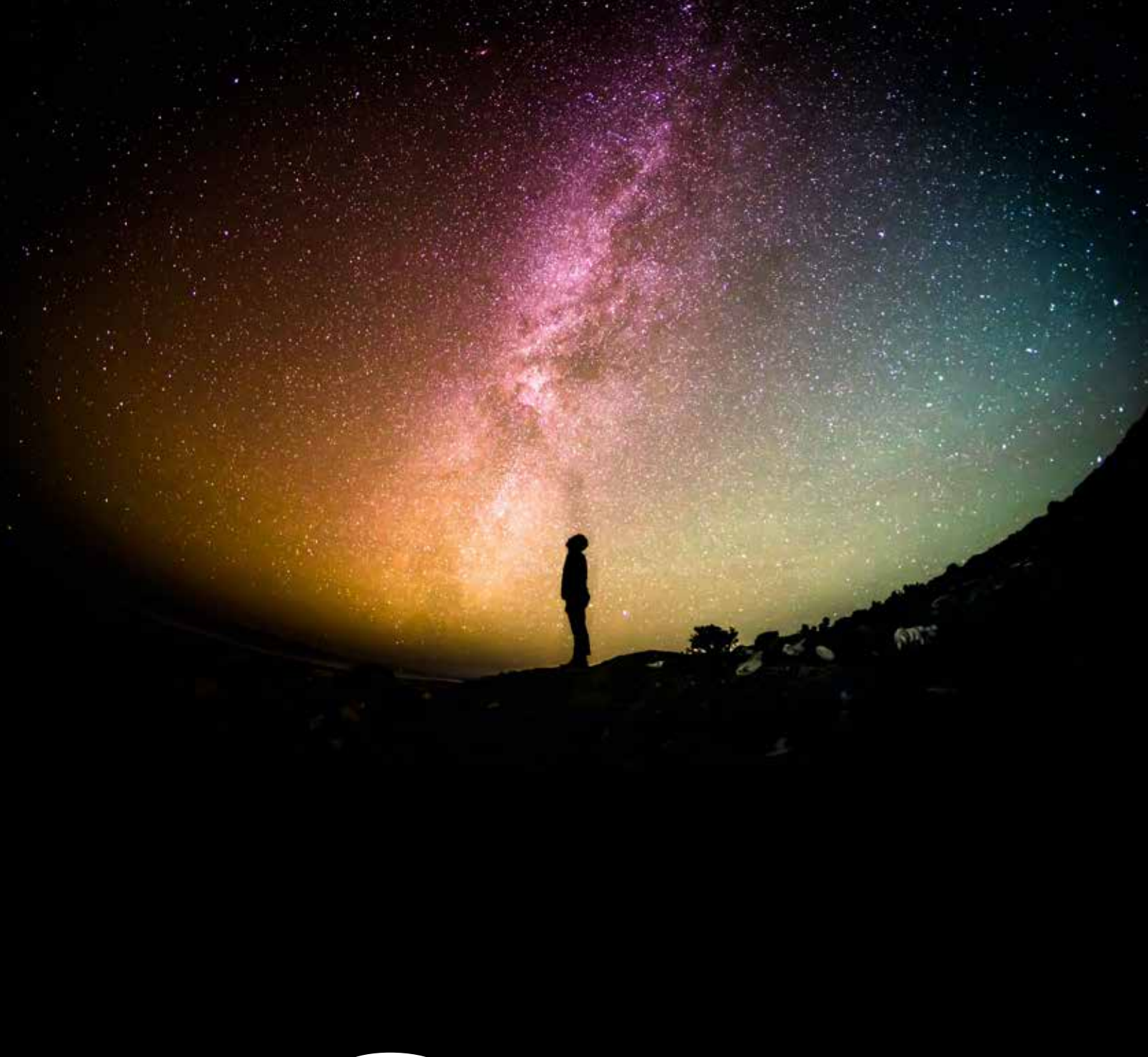

STEM

BUILD THE FUTURE

A LETTER FROM THE UTAH STEM ACTION CENTER

Welcome to this special edition magazine that is all about STEM! Why do we care about STEM so much that we want to dedicate an entire magazine to fun and exciting stories about STEM?

It starts with understanding what STEM is, which is much more than the acronym – STEM – or science, technology, engineering and math. We believe that STEM is a way of thinking, doing and exploring. It gives the world a sense of wonder and helps to grow curiosity. It can give all of us a "toolbox" to solve problems, with solutions in medicine and healthcare, transportation, communication, environmental challenges, and defense. STEM is for everyone!

STEM also pairs well with so many other things like art, sports, and history. For example, an understanding of STEM can help with athletic performance, safety and treatment of injuries. The technology and engineering in sports equipment is fascinating and a major industry in this country. Graphic design and digital media are great examples of where art and STEM work together to result in inventive brand design and video games. The design of products, such as the iPhone, is high tech at its artistic design best! My favorite has always been history. So often we forget how understanding innovation and technology has shaped our history and culture, as well as our lifestyle. Our ability to communicate with a few thumb maneuvers through a text, or make a payment with Venmo reminds us of how technology has changed our lives.

I invite you to flip through these pages and enjoy the stories of STEM and let them inspire you to think of ways that it has changed your life, or your child's life. I also encourage you to contact us at the Utah STEM Action Center if you have questions about STEM education, careers and resources! 👽

Best wishes,

Tami Goetz, Ph.D.
Director, Utah STEM Action Center

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The Impact of Energy in our Life

Energy is all around us and comes from a variety of sources — the sun, water, wind, coal, oil, natural gas and even wood. It powers our daily lives — the phones in our pockets, the game consoles at home, the lights in our room, the cars in our garage, the heat in our buildings and even the production of the clothes we're wearing.

Energy efficiency and conservation play an integral role in meeting the demands of our thriving economy and growing population. Energy efficiency simply means using less energy to do the same thing, while energy conservation means any action that reduces energy use. Everyone can conserve energy, be more efficient, save money and preserve the environment.

Think about electricity. It's all around us and enables so much of what we do each day. But where does it come from? What does it cost to actually use? And how can we be more efficient in how we use it?

How much energy does your home use each day? Below is a list of everyday items that use energy. Count the number of those devices in your home and then multiply that by the cost per day. At the bottom you'll see the estimated total cost of energy in your home each day. What can you do to conserve energy and be more energy efficient?

Item	Quantity in the house	Cost per day	Total cost per day
Phone (charging 10 hours)		$0.15	
TV (4 hours/day)		$2.16	
60-watt incandescent light bulb (5 hours/day)		$0.90	
Game console (3 hours/day)		$0.52	
Desktop computer (8 hours/day)		$3.37	
Fridge (24 hours/day)		$14.46	
Air conditioner (4 hours/day)		$1.93	
Dishwasher (2 hours/day)		$2.38	
Washing machine (1 hour/day)		$0.92	
Dryer (1 hour/day)		$10	
Ceiling fan (24 hours/day)		$3.02	
Total cost per day			

UTAH GOVERNOR'S OFFICE OF
ENERGY DEVELOPMENT

Committed to Energy Education

The Governor's Office of Energy Development (OED) is focused on educating and building the energy workforce of tomorrow.

Energy, STEM and Workforce Development

Energy jobs pay nearly twice the Utah average. Utah is a national leader in energy research, innovation and workforce development and is deeply integrated with the energy industry and renowned institutions and laboratories — including the University of Utah, Utah State University and FORGE. OED helps cultivate the energy workforce of tomorrow in a variety of ways.

The Utah Power and Energy Career Expo

Since 2018, OED has partnered with the University of Utah to bring together companies, students and faculty to showcase local, regional and national programs and careers in the power, energy and mining sectors. More than 300 future members of the energy workforce have directly engaged with energy professionals on career opportunities in the industry. The Utah Power and Energy Career Expo is co-organized with Utah Smart Energy Laboratory (U-Smart) and the Career and Professional Development Center at the University of Utah.

Energy Curriculum and Professional Development

OED has partnered with the Utah Science Teachers Association (USTA) to provide more than 35 energy lesson plans that meet state SEEd standards. They are available for free at energy.utah.gov/education/curriculum. In partnership with USTA, OED also sponsors teacher training events that walk through the energy curriculum. These trainings are free and include lunch, lesson supply kits and relicensure points. OED also covers the cost of finding substitute teachers.

Utah Energy Workforce Scholarship

In partnership with Chevron, OED has provided over $90,000 in scholarships to students pursuing STEM education at a Utah institute of higher learning. This includes universities, trade and technical schools and community colleges. Visit energy.utah.gov/energy-education/scholarships to learn more.

UTAH GOVERNOR'S OFFICE OF
ENERGY DEVELOPMENT

I AM A WOMAN SCIENTIST, AND WE NEED MORE OF THEM

Here's how I got my start in a male-dominated industry, and why that's important.

By: Layne Wells

I WAS BORN between the cloning of Dolly the sheep and the release of famous movies like *Gattaca* and *Jurassic Park*. My early life and memories are speckled with advances in genetics, healthcare, and pop culture. At the turn of the 21st century, when I was mastering my ABCs, As, Gs, Cs, and Ts were being mapped into the human genome.

Developments in genetics and the newly termed "STEM" were booming all over the world, but it would still be over a decade before STEM took root in my life and led me to a dream career in genetic counseling. Instead, I dreamt I would become a real-life Nancy Drew, armed with at-home science kits and a trusty magnifying glass. Inspired by my childhood heroine, I loved solving puzzles and made plans to resolve life's greatest mysteries.

HOW I FELL IN LOVE WITH SCIENCE

The science classroom was my favorite place to ponder these mysteries of life. Here, teachers encouraged me

"Each day brings the opportunity to learn something new and, instead of being afraid, I am excited by the idea of unanswered questions and lingering uncertainty.

to build hypotheses, design experiments, and gather evidence in support of an argument. My early geology kits changed into clay models of plant cells, which in turn, were replaced by circuit boards — chemistry, biology, and physics bouncing off each other and refracting their core lessons in new settings.

By the time high school was over, I felt torn between hard science and the humanities. I knew a path in healthcare was the right fit for me, and that meant studying hard science. But would I have to give up my passions for language, ethics, psychology, and art? Did I have to surrender a part of myself to go into medicine?

I chose to go to a historically women's college in California and declared a major in neuroscience with an added focus in Chicanx-Latinx Studies. My path led me to pair my STEM-based classes with ones that taught cultural humility and language skills. Since I attended a historically women's college, being a woman in STEM was unremarkable. I was accepted by my professors and peers and encouraged to explore career options that fed all my interests.

While in school, and now working full-time in cardiovascular genetics at Primary Children's Hospital, I'm still met with the same question from strangers when they find out I work in healthcare: "Are you a nurse?" The question, although it sounds harmless, is unnerving. My male colleagues are never asked this, though exceptional nurses come from all genders.

All across the country, I meet people who I feel underestimate my expertise, my training, and my ability to speak for myself based on my gender alone. These stereotypes about women in STEM are damaging, not just to individual self-worth and a sense of belonging, but also because they play into a long history of discrimination in science.

But it's changing.

HOW MORE WOMEN CAN GET INVOLVED IN THE SCIENCES

2020 has presented us with a unique cultural moment in STEM. More people are sharing their experiences than ever before and thanks to their bravery, we can all take part in this movement for social change for women and minorities in STEM. Their stories show us that injustices against women, people of color, and other structurally oppressed communities can be traced back to the foundations of science and education. It is important to recognize how this history has lasting effects of prejudice in our workplaces, in research, and in the field today.

As scientists, we know there is power in knowledge, and coming to terms with these stories empowers us to act. When we listen to the stories of our peers, our teachers, mentors, and our community, we are given the privilege to honor them. Our stories connect us, across time and space. After all, good science comes from great record-keeping and reflection.

"It's time our science, both in research and in those who work in STEM, reflects the diversity of the world around us.

It's time our science, both in research and in those who work in STEM, reflects the diversity of the world around us. It was Rosalind Franklin, whose work on the discovery of DNA's structure was stolen by her male colleagues and published without acknowledgment of her efforts, who said, "Science and everyday life cannot and should not be separated." It is vital that today's scientists, young and old be willing and ready to have these hard conversations and embrace work that makes STEM accessible.

As I think back on my Nancy Drew and Rosalind Franklin-inspired journey to STEM, I am empowered to do scientific work that connects different areas of research and work that connect me to my community. These days, I am working to become a genetic counselor, a role that combines all my passions for molecular genetics, ethics, humanities, and empathetic care for my patients.

STEM has taught me the value of pushing boundaries and asking tough questions. It allows me to advocate for my patients and my peers. Each day brings the opportunity to learn something new and, instead of being afraid, I am excited by the idea of unanswered questions and lingering uncertainty. STEM teaches us valuable lessons in collaboration and critical thinking, but when we branch out and explore all our passions, we're given the tools to build a more equitable pathway to STEM for all. 👽

A BYU GRAD IS HELPING NASA FIND LIFE ON MARS

How STEM skills translate to progress in aerospace.

By: Emily Lehnardt, MS

USING SCIENCE, TECHNOLOGY, engineering, and math principles to land astronauts on the moon and explore our solar system, NASA is one of the most recognizable companies that is constantly integrating STEM into their research.

HOW NASA MADE SPACE TRAVEL POSSIBLE

For example, to transport astronauts safely to the moon in the 1950s, NASA needed a rocket. At the time, the US had ballistic missiles but not rockets safe for human flight. NASA needed to figure out how to get astronauts safely to the moon, and doing so required them to use biology and technology to collect data on potential effects of space flight on humans and animals.

They worked tirelessly to build a rocket called the Mercury-Redstone launch vehicle (MR-1). After a lot of work and test flights, NASA engineers, scientists, technicians, and mathematicians watched in anticipation as the rocket began to slightly move upward. Things were looking

well for the scientists and crew members, then the engine shut off, causing the rocket to settle back onto the launch pad.

The incident caused NASA to abort their first launch and scientists were understandably disappointed.

NASA used this opportunity to collect data, record results, revise ideas, and improve procedures. Despite MR-1 being a "failure," they launched MR-1A a short time later with the successful launches of MR-2, MR-3, and MR-4. The challenges and failures NASA scientists and engineers experienced improved their designs, deepened their ambition, and sharpened their understanding of STEM principles which ultimately paved the way for the first group of astronauts to walk on the moon in 1969.

HOW ONE BYU GRAD IS HELPING NASA FIND LIFE ON MARS

Jani Radebaugh is a planetary scientist at BYU who began her STEM quest in both movies and in astronomy. She watched *Star Wars* as a child and decided she wanted to explore space. Then, she studied astronomy to try to understand the secrets of distant stars and planets. Much later, she found that she could use geology to act as if she were on the surface of another planet, exploring it for the first time.

STEM fields allowed Radenbaugh to navigate her career path and find something she loved. Now Radebaugh travels the world with NASA, comparing geological features on Earth to geological features on other planets and moons. Recently, NASA selected her team to create, build, and land a drone-like rotorcraft, named Dragonfly, to Saturn's moon, Titan.

"Dragonfly will explore Titan's orange and brown sand dune desert landscape and methane riverbeds, making my dream of traveling to Titan closer to reality," says Radebaugh, mentioning that the landscape on the mood includes rivers of methane and plenty of sand dunes. These rivers and dunes, believe it or not, create all of the ingredients necessary for life.

The goal of the program, she says, is to test if the conditions on Titan are right for life by looking to see if it already exists. In order to do so, she and her team must utilize every

Mars

aspect of STEM. “We will have to engage all the fields of STEM to recognize and interpret life if and when we find it. Most of us think it will probably exist in a form that’s difficult for us to recognize,” she says.

“We need to use physics to see if the heat and behavior of the environment is being modified by life, to use chemistry to analyze the chemical reactions created by life, to use geology to see the shapes or even fossils in the rocks, engineering to bring the correct instruments to measure the materials, and math to understand if the numbers we are seeing are correct. This adventure on Titan that we will undertake with Dragonfly will require all of our mental resources.”

Though the field can be challenging at times, Radebaugh is excited to see what the next generation of scientists will make possible at NASA with STEM and encourages students to take the leap, for it could be a career perfect for you.

“The fascinating world of STEM enhances communication, creativity, collaboration and thinking critically to solve real-life problems,” she says. “Improving upon our failures to overcome challenges, we can assist each other in our universal quest to discover the hidden treasures of science, technology, engineering, and math.” 👽

MASKING UTAH

by **ELLEN FAGG WEIST**

MAYBE WE'LL REFER TO 2020 AS THE YEAR OF THE MASK. In Utah, the demand for personal protective equipment sparked remarkable partnerships, linking the technical expertise of maker spaces, like the Utah PPE Makers Group, with a fleet of available 3-D printers in maker spaces, schools, universities and libraries.

The goal? To print shields for healthcare workers, super powered by a $20,000 donation from Micron Technology. In March, UServeUtah set a goal seeking 10,000 face shields. By July, community partners had printed and donated more than 18,000; extra shields were offered to dental workers. "It was amazing to watch the community come together and solve problems," says Becca Robison, program manager at STEM Action Center, which connected schools and libraries to the mask-making effort. "It's been so amazing and humbling to see people jump into action."

Now the collaborators are working with the state's Division of Indian Affairs and American Indian Services to donate six 3-D printers (and 120 rolls of filament) to the Navajo Nation.

Beyond masks and shields, the partners have ambitious plans to find other ways to use this informal, never-been-connected network of printers. "If the need arises, a lot of people are interested in printing again," Robison says. "We've got a lot of partners ready to step up to the plate."

Originally published in the Utah Department of Heritage & Arts' MUSE magazine. For more stories, visit: ***bit.ly/MUSEfall2020*** *or sign up here:* ***bit.ly/MUSEemails****.*

STEM ACTION CENTER U·T·A·H

DURING EMERGENCIES, Utah receives credit toward Federal Emergency Management Agency matching funds by volunteering or donating resources through UServeUtah. To donate or volunteer, call 888-755-UTAH (8824), email volunteers@utah.gov, or visit userve.utah.gov/disaster-volunteer.

PRINT face shields for medical workers on your own 3D printer and donate them through UServeUtah: stem.utah.gov/covid-19-response-3d-printing.

VISIT UServeUtah's resource page to find volunteer opportunities, donate supplies, access COVID-19 resources, and recruit volunteers: userve.utah.gov/emergency-response.

> **stem.utah.gov**

Utah STEM Action Center

3D PRINTING OUR WAY TO A BETTER WORLD

Thanks to 3D printing technology.

By: Tamara L. Goetz, Ph.D

WHAT IF YOU COULD replace a body part with the push of a button? Engineers are working to do just this by developing the ability to mass print organs for transplant, including blood vessels and heart valves. Or what if you could whip up your dream house or boat? One like the 25 ft, 5,000-pound patrol boat that the University of Maine printed in only 72 hours? Though it sounds like something out of a science-fiction movie, things like this aren't just a dream anymore thanks to the advent of 3D printing.

It's pretty magical what you can do with 3D printing. In fact, 3D printed objects commonly change human and animal lives for the better. For example, technicians can use printing technology to create replacement limbs for animals. There are even some amazing stories about eagles and toucans that have had "beak replacements" made possible by this incredible technology.

3D printing has been used for a wide variety of disciplines including manufacturing, architecture, and medicine. Compared with traditional manufacturing methods, 3D printing is faster and easier to customize. Almost

"3D printed objects commonly change human and animal lives for the better.

anything can be printed, in any size or shape, using one machine, and materials are recyclable which creates less waste.

There are so many possibilities for 3D printing, and they can happen in your home. It's becoming more common for households to have a 3D printers to foster creativity and resourcefulness. These kinds of printers can be used to create that missing part for a do-it-yourself auto restoration project. Or you can make kitchen tools such as citrus juicers or bag clips, or create an unlimited supply of carabiners for use in nearly every room. 3D printers can even be used to make new toys.

"3D printing can change the whole paradigm of how our children will see innovation and manufacturing in America," says Makerbot CEO, Bre Pettis.

If you're eager to be a part of that innovation, we invite you to email our "Save the World with 3D Printing" expert, Becca Robison at beccarobison@utah.gov with any of your printing ideas. You can even put your idea out there on Snapchat or Instagram using the hashtag #STEMweek or mentioning @STEMutah. If your idea passes Becca's inspection, we will take it to the STEM Action Center's Innovation Hub and send you an invitation to give your idea a try.

It's pretty magical what you can do with 3D printing. We hope you think so too.

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At US Synthetic, our vision is to improve lives. That's why, we're working hard to support the development of tomorrow's problem solvers in our local schools through STEM education programs. Through our Engineering Good initiative, we're teaming up with like-minded local partners—Utah Underwater Robotics, Thanksgiving Point, Infini-D Learning, and others—to donate thousands of hours of service yearly to make a difference.

ENGINEERING GOOD

Building the World's Best

PROBLEM SOLVERS

STEM education is a vital way to encourage and inspire young minds. Join us in supporting the leaders of tomorrow.

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Did you know?

Thanksgiving Point has STEM!

Whether you visit our venues or participate in our programs, there is always an opportunity to learn at **Thanksgiving Point**! Our multitude of hands-on STEM learning experiences are a fun way to discover the natural world, design solutions to real-world problems, try your hand at entomology, paleontology, robotics, engineering, coding, and much more. Our in-house experts and trained educators guide learners of all ages in their discovery of science and engineering and support their in-school curriculum with proven exploration-based learning techniques. Come to Thanksgiving Point to have fun with science, make new friends, and make school easier!

Out-of-school learning experiences are proven to increase academic achievement, improve attitudes toward learning, school, and teachers, boost social and emotional development, and promote health and wellness.

For more information on camps, classes, and other STEM-related activities, call 801.768.4971 or visit us online at ThanksgivingPoint.org/Education.

HOW SCIENCE AND TECHNOLOGY CAN MAKE YOU A BETTER FILMMAKER

STEM disciplines are used in virtually every aspect of filmmaking.

By: Becca Robison

YOU'RE SITTING IN A movie theater with your 3D glasses on and popcorn in your lap. Suddenly a hyper-realistic Velociraptor pops out of the screen and its shrieks and hisses rumble through the theater's surround sound. You take another bite of popcorn and settle in to absorb all of the magic—these are the moments that make movies incredible.

Though it's easy to get whisked on an adventure in the cinema, what you might not realize is that none of these incredible movie moments could have been possible without science, technology, engineering, and math, also known as STEM.

COMPUTER-GENERATED GRAPHICS ARE CREATED WITH TECHNOLOGY

In today's industry, nearly every movie released is touched in some way by computer-generated imagery (or CGI). While the CGI is obvious in some movies—like Thanos from the Marvel Universe, the dinosaurs in *Jurassic World*, or the appearance of a young Leia at the end of Star Wars' *Rogue One*—it's more subtle in others. CGI can also be used to add tears to a character's eyes or even change the facial expressions in a scene altogether.

CGI is a creative mind's *dream* because it combines the perfect blend of STEM and art, and it's possible to bring anything that you want to life. CGI gives filmmakers the power to create entire highways from still images instead of closing down major roads to film scenes, or even to create complete fantasy worlds.

SPECIAL EFFECTS MAKEUP REQUIRE A WORKING KNOWLEDGE OF ANATOMY

Before CGI was introduced to the industry by University of Utah scientists Fred Parke and Edwin Catmull, special effects makeup was used to create classic looks like those in *Creature from the Black Lagoon* or *Planet of the Apes*. Even today, high-quality special effects makeup and prosthetics is key to creating realistic and believable scenes in movies. And guess what? This requires STEM too.

When special effects makeup artists begin creating their art, it's critical that they have a good understanding of the anatomy of what they are creating. This knowledge of anatomy is necessary when creating realistic scratches, bruises, and gashes on a human character after they have been through battle. In the industry, it's no secret that understanding the human body is the key to creating award-winning special effects makeup!

And what about monsters? If a monster has gills, makeup artists need to study aquatic gill-having animals to ensure they're movie-monster looks right. If the creature is extra hairy, makeup artists study extra hairy animals for inspiration. The key to being a well-rounded special effects makeup artist is having a good understanding of many different types of creatures right here on Earth!

Whether you're obsessed with watching makeup artists on YouTube or just love going all-out on Halloween, now is a perfect time to take the leap and start testing out special effects makeup! Dream up a character, or draw inspiration from your favorite cinematic beasts. Do a bit of research, and you'll be delighted by the amazing things you can create when you blend makeup and anatomy.

SOUND TECHNICIANS USE SCIENCE TO CREATE SOUND EFFECTS

CGI and special effects makeup work together to create an immersive visual experience for the moviegoer, but without *sound* that film experience isn't quite complete. Much like with CGI and special effects makeup, the creation of sound effects for movies isn't just an art, it's a *science.*

Many of the organic sounds you hear in films—like a character walking, chewing, or swishing their coat—aren't created on set during filming. Instead, production companies work with foley artists who tirelessly work to create the realistic sounds heard while watching movies.

Foley artists use a collection of odds and ends to create their sound effects. When doing this, they examine the physical characteristics of the items they're using compared to what's shown on screen to ensure accuracy of sound. Artists also have to have a solid understanding of *resonance*— the vibrations, amplitudes, and pitches that work together to create different sounds. Understanding resonance allows foley artists to make a wide variety of sound effects with only a few objects.

STEM disciplines are used for virtually all of the movie making experience. Next time you watch a movie with your friends or family, pay special attention to the art and STEM elements that bring the movie to life! How can you recreate them in your own projects? Now is the time to start creating! And who knows, if you choose a career in this field you might end up working on a team that creates an Academy-Award-winning film. 👽

SEARCH AND RESCUE RESPONDERS USE STEM TO SAVE LIVES

In the great outdoors, physics, geology, and technology can mean the difference between life and death.

By: Colleen Fisher

IMAGINE YOU'RE A first responder with Salt Lake County Search and Rescue (SLCOSAR). You're on call, five miles up Little Cottonwood Canyon. When you arrive, you discover that the skier fell into a small ravine only reachable by snow anchor.

You assess what you're looking at: It's a 60-degree slope, a 160-pound skier, with 30 vertical feet below you. You have to understand how deep to drill the anchors into the snow to ensure it holds. What type of pulley system will need to be used? How long should the rope be to make it down and back safely?

You have to ensure there is nothing that could put you or your team in danger during the rescue—that means understanding snow science and the geography of the area. You need to know the water density of the snow, the layers of the snow from past storms, and whether there is a weak layer that could cause an avalanche. You also must understand avalanche paths created by gullies on the mountainsides and where those can most likely occur.

Though search and rescue careers might not appear to be related to STEM disciplines, the reality is that

these professionals spend their time using physics, biology, math, and engineering to solve problems like the ones presented in the hypothetical rescue mission. And those abilities save lives!

CAREERS IN SEARCH AND RESCUE

First responders on the SLCOSAR team often join because they, like the people they rescue, love to spend time in the outdoors. They also have a knack for learning the technical skills of the job: setting up complex anchors, using pulley systems to lift unconscious patients from vertical terrain, controlling a drone to find the patient before setting out, rigging rope systems across rivers, and so much more. These professionals train for months and years to learn all the skills needed for any situation they are called to respond to.

In addition, all members of Salt Lake County Search and Rescue are emergency medical technicians (EMTs). Traditionally, an EMT works in an ambulance and treats patients until they arrive at the hospital, but they also work out in the wilderness to provide medical help to those being rescued. In the case of search and rescue, EMTs can help check for spinal injuries, check vitals, set broken bones, or aid with any immediate medical ailments before orchestrating a safe rescue.

In the state of Utah, a high school diploma is the only thing needed to be eligible for a career in search and rescue, though an EMT intensive course is also required. You will also have to take two exams to receive your license at the conclusion of the program. Being an EMT requires a vast knowledge of the science of the human body, and it can be useful to take a physiology or anatomy class in high school if you're interested in a search and rescue career.

SEARCHING WITH STEM

Aside from an EMT certification, it's necessary for search and rescue workers to have a working knowledge of geography and snow science in order to identify and utilize the terrain

the location of a lost hiker, climber, or skier is unknown, rescue teams rely on drones to quickly aid them in their search. This is a much quicker method than the technologies previously employed like on-foot search parties and teams of dogs. The usage of drones over on-foot methods allows a person to be found in minutes, instead of weeks, greatly increasing odds of survival.

Once patients have been found, search and rescue team members will often call for Life Flight support because it can take too much time to transport an injured person down rugged terrain. Though modern technologies like drones and helicopters help rescue those in need much quicker, sometimes rescues can take hours at a time.

surrounding the injured persons. For example, in the instance of the stranded skier, rescue workers have to be able to identify whether a certain rock is suitable for an anchor and whether weak layers in the surrounding area could cause an avalanche.

Additionally, search and rescue workers require a working knowledge of technology. In cases where

Regardless of the intense nature of the job, search and rescue could be a great option for students who love the great outdoors and are passionate about STEM. After all, if it weren't for the motivated, knowledgeable, and passionate volunteers on SLCOSAR, anyone who got hurt or lost in our local canyons would have no one to call. 👽

EARLY COLLEGE

WHEN NATURE INSPIRES SCIENTIFIC ADVANCEMENTS

The art of biomimicry can be used to inspire architecture, medicine, and even apparel.

By: Kellie Yates

HAVE YOU EVER HEARD about biomimicry? Biomimicry, also called biomimetics, is the art of copying the natural world. Examples of this are commonly seen in architecture, vehicle design, medicine, and even in textiles. And though biomimicry might sound like some sort of new-age design wave, it's actually been around for thousands of years.

The earliest examples of biomimicry are ancient societies making shelters from caves and the first umbrellas invented in China. These were invented more than 1700 years after children began to use leaves to shelter their heads from rain. Inspired by nature, they created a product that had the same effect.

Since then, the art of biomimicry has expanded. The shape of submarines was inspired by whales, trains have been designed to be aerodynamic like a bird's beak, and robot hands are designed to copy the fluid and gentle movements of an elephant's trunk. Even Leonardo DaVinci's flying machines, called ornithopters were based on birds, as are the planes used today.

Velcro, actually is one of the best examples of biomimicry. It was created in 1955 by Swiss engineer, George de Mestral after he noticed that burrs kept getting caught in his dog's hair during walks. Fascinated by the hooks in the burrs that created this attachment on the dog's hair, he copied nature's design and turned it into a product.

BIOMIMICRY IN ARCHITECTURE

Building design has also been impacted by biomimicry. One example includes the unique Sagrada Familia church in Barcelona, designed by architect Antoni Gaudi. Using the structure of branching trees as inspiration, he created gorgeous beams to hold the vaulted ceiling of the church up. Though construction first started in 1882, it still continues to this day.

Another example of biomimicry in building design is the Eastgate Centre in Zimbabwe. Though the building doesn't appear to be inspired by nature at first glance, the building's ventilation system is based on the engineering found in African termite mounds. The mounds are built to stay a consistent temperature, despite any kind of temperature extreme. The Eastgate Centre does the same by using a passive cooling system that stores heat during the day and releases it at night when temperatures are cooler.

Biomimicry also exists a little closer to home as well. At the College of Law on the campus of the University of Utah, the glass on the outside of the structure has a patterned, reflective coating that mimics the webs of Orb Weaver spiders. Because of this, birds avoid the structure, reducing the risk of them hitting the glass.

"The shape of submarines was inspired by whales, trains have been designed to be aerodynamic like a bird's beak, and robot hands are designed to copy the fluid and gentle movements of an elephant's trunk.

BIOMIMICRY IN TECHNOLOGY

More recently, biology-inspired designs have been seen in robotics, prosthetic designs, and medicine. In fact, these designs are creating some incredible technologies in regards to patient comfort. A special type of micro-needle developed by researchers at Ohio State University copied a mosquito's proboscis and is thought to be pain-free for patients, though the design is still in the works.

Another example of potential biomimicry in medical fields is a medical adhesive inspired by the slime produced by European slugs when they're stressed. The slime is super sticky and flexible, making it a great material for use in laboratory settings when stitches aren't ideal.

Even drones are being built to look *and* act like insects, small birds, bats, and even fish. The Massachusetts Institute of Technology (MIT) created a dog-type robot that is very stable on its four legs. These animal-robots have a variety of uses, including exploring environments that are not safe for humans, collecting data about water quality, and sending that information back to scientists.

BIOMIMICRY IN APPAREL

Biomimicry has such a wide reach that even competitive swimsuits have been made with a material that mimics shark scales, decreasing drag on swimmers in the water. Another animal known for its speed, the cheetah, has been the inspiration behind the running shoe worn by Asafa Powell in the 2008 Beijing Olympics and the cheetah leg prosthetics used by athletes in the Paralympics.

Athletic apparel designed to keep wearers cool was inspired by pinecones. In nature, when a pine cone is in a humid environment, the pine cone closes up. When the environment is less humid, the pine cone opens and releases its protected seeds. A fabric called Inotek was developed to do the same. When there is more moisture in the environment (or your body is releasing more sweat), tiny air pockets open in the textile, cooling you and wicking away any wetness.

Biomimicry can allow for more effective and efficient designs. In fact, the Biomimicry Institute holds a competition every year called the Youth Design Challenge for high school

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student teams. This year the focus is on biology-inspired designs that can help solve problems associated with climate issues. For more information, check out the webpage youthchallenge.biomimicry.org. For educators both formal and informal, a curriculum aligned with NGSS standards is offered to support the inclusion of biomimicry in and out of classroom settings. Find it on the Biomimicry Institute website.

BECOME A MECHANIC FOR THE HUMAN BODY

Biomechanical engineers use physics to improve the performance of the human body.

By: Kellie Yates

SCIENTISTS WHO STUDY biomechanics are usually interested in applying physics to analyze the capabilities of the human body, animal systems, the mechanics of cells, and other living things. That can mean working in fields such as biology, personal training and physical therapy, or sports equipment design. All of these fields require some knowledge of biomechanics— whether you use them to design a pair of tennis shoes or to understand how cell compounds work.

If you are interested in a career in biomechanical engineering, you're going to need to learn about anatomy, physiology, engineering, math, and physics. All of the tools provided to you in these types of courses will give you the skills needed to hack the human body and succeed in biomechanics. Because a lot has to do with biomechanics, even levers, believe it or not.

WHAT YOU NEED TO KNOW ABOUT LEVERS

A lever is one of the six simple machines that can amplify the work

"Athletic trainers can spend a lot of time studying and improving the movement of athletes to decrease chances of injury.

being done with a change in force and distance. Made of three components—a fulcrum, a load, and the effort—levers have been used by humans, and even some animals like otters and orangutans, since prehistoric times to help accomplish daily tasks.

The human body is actually full of levers. The fulcrum is the joint, the load is the weight of the body or part of the body, and the effort occurs when your muscles make movement happen. All of the joints in your body are one type of three levers, and in order to find success in biomechanics, it's important to know the differences. When we can identify the type of lever the body is designed to be used within a specific movement, we can improve our physical abilities and decrease potential injuries.

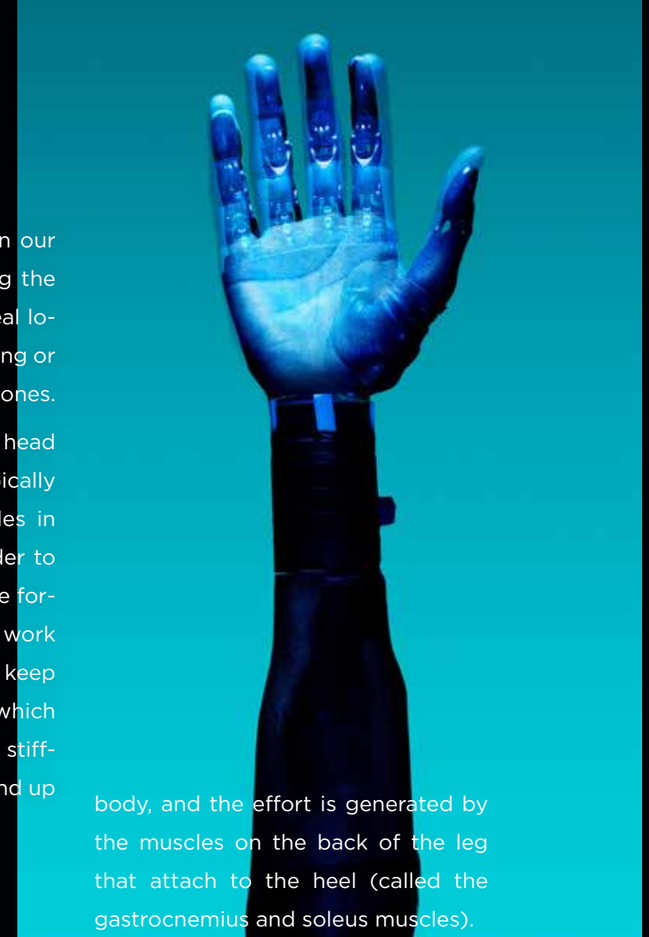
FIRST-CLASS LEVERS

First-class levers have a fulcrum in the middle of the system, with the load at one end and the effort on the other end. Examples of first-class levers are things like a teeter-totter (also called a see-saw), a pair of scissors, or the claw end of a hammer when a nail is being removed from the wall.

There aren't too many first-class levers in the human body, but examples include the system used to nod your head up and down, the muscles and joints involved in straightening your elbow, and when you use your muscles to rotate your leg in the air.

Have you heard of the phenomenon called "tech neck"? This is an increasing problem that can cause headaches, neck and shoulder tension, and back pain. It happens when our head is pushed forward, moving the weight of the head off of its ideal location, to do things like use texting or watching videos on our smartphones.

This happens because our head moves forward more than it typically would, which makes the muscles in the back of our neck work harder to keep our head upright. The more forward your head goes, the more work your neck muscles have to do to keep you upright and balanced, which can lead to muscle fatigue and stiffness. It really is important to stand up straight!



SECOND-CLASS LEVERS

The load is in the middle of second-class levers, and these types of levers are often seen on certain things like a wheelbarrow, a stapler, and bottle openers. In the body, an example of a second-class lever happens when you use your lower leg muscles to stand on your tiptoes.

In this example, the fulcrum is the joint between the toes and the foot (called the metatarsophalangeal joints), the load is the weight of your body, and the effort is generated by the muscles on the back of the leg that attach to the heel (called the gastrocnemius and soleus muscles).

This lever is especially important when it comes to running shoe design—if a shoe is too stiff to allow the ankle lever in the foot to naturally move or inhibits the movement at the ball of the foot, another second class lever, the weight of the body can be amplified, forcing the person wearing the shoe to move unnaturally and exert more energy for the same level of movement, which can cause injury to all of the muscle in your legs, hips, and even your lower back.

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THIRD-CLASS LEVERS

The effort is in the middle of the system for third-class levers. Using chopsticks, shoveling, or rowing a boat could all be considered examples of third class levers. Believe it or not, most of the joints in the body work as third-class levers, but some specific examples include bending your elbow and bending your knees. These types of levers are used in the body to run, jump, kick, and more! They specifically allow for speed and a large range of motion.

Have you ever heard someone say "lift with your knees"? This is because the motion associated with lifting weight with the muscles in the back is a third-class lever, and is easier to damage than the knee joint. Athletic trainers can spend a lot of time studying and improving the movement of athletes to decrease chances of injury while strengthening the muscles associated with third-class levers, like shoulder, hip, and core muscles.

By combining knowledge about the human body and levers, people who study biomechanics can improve the performance of the human body, prevent injury, develop prosthetic devices, and more. If this is something you are interested in, consider taking classes in physics, math, anatomy, and physiology.


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